

What is claimed:

1. A system for synthesizing a nano-scaled powder material, comprising:

- (A) a chamber for receiving nano-scaled clusters generated from a material selected from the group consisting of a metal, a metal compound, and a ceramic;
- (B) a twin-wire electrode device in supplying relation to said chamber for supplying nano-scaled clusters therein, said electrode device comprising
 - (i) two wires made up of said material, with each wire having a leading tip which is continuously or intermittently fed into said chamber in such a fashion that the two leading tips are maintained at a desired separation; and
 - (ii) means for providing electric currents and a working gas flow for creating an ionized arc between the two leading tips for melting and/or vaporizing said material to generate said nano-scaled clusters;
- (C) means for injecting a quench gas and/or a reaction gas into a quenching/reaction zone inside said chamber at a point inside said arc or downstream from said arc to facilitate the formation of nano-scaled powder particles; and
- (D) means to collect the nano-scaled powder material.

2. The system as defined in claim 1, further including a second plasma arc zone below said ionized arc to vaporize any un-vaporized material dripped therefrom.

3. The system as defined in claim 1, further including a reservoir disposed at the bottom portion of said arc or a distance below said arc in such a fashion that said reservoir receives any un-vaporized material from the wires and exposes said un-vaporized material to the heat energy of said arc to further vaporize at least a portion of said un-vaporized material.

4. A system for synthesizing a nano-scaled powder material mixture, comprising:

- (A) a chamber for receiving nano-scaled clusters generated from two materials of different compositions with each material selected from the group consisting of a metal, a metal compound, and a ceramic;

0 (B) a twin-wire electrode device in supplying relation to said chamber for providing nano-scaled clusters therein, said electrode device comprising

5 (i) two wires respectively made up of said two different materials, each wire having a leading tip and each wire being continuously or intermittently fed into said chamber in such a fashion that the two leading tips are maintained at a desired separation; and

(ii) means for providing electric currents and a working gas flow for creating an ionized arc between the two leading tips for melting and/or vaporizing said materials to generate said nano-scaled clusters;

10 (C) means for injecting a quench gas and/or a reaction gas into a quenching/reaction zone inside said chamber at a point inside said arc or downstream from said arc to produce a nano-scaled powder particle mixture; and

(D) means to collect the nano-scaled powder material mixture.

15 5. The system as defined in claim **1, 2, 3, or 4** further including wire feed and control means to regulate the feed rates of said two wires.

1S 6. The system as defined in claim **1, 2, 3, or 4** wherein said means for providing electric currents comprises an electric power supply selected from the group consisting of a high-voltage source, a high-current source, a pulsed power source, and combinations thereof.

20 7. The system as defined in claim **1, 2, 3, or 4** further including means for controlling the rate of flow of the quench gas and/or the reaction gas, thereby enabling change of particle size of the nano-scaled powder material.

8. The system as defined in claim **1, 2, 3, or 4** wherein said reaction gas is selected from the group consisting of nitrogen, phosphorus, arsenic, oxygen, sulfur, selenium, tellurium, fluorine, chlorine, bromine, iodine, a carbon-containing gas, and mixtures thereof.

9. The system as defined in claim **1, 2, 3, or 4** wherein said working gas is selected from the

0 group consisting of nitrogen, hydrogen, noble gases and mixtures thereof.

10. The system as defined in claim 1, 2, 3, or 4 wherein said means to collect the nano-scaled powder material comprises a cyclonic mixer for turbulently mixing said nano clusters produced in said reaction zone for cooling said nano clusters to become a solid nano powder and means for filtering the nano powder material from gas flowing through the system.

5 11. The system as defined in claim 1, 2, 3, or 4 wherein said means for injecting comprises a concentric gas injection device adjustably positioned along the location of said ionized arc.

12. The system as defined in claim 1, 2, 3, or 4 wherein said quench gas is selected from the group consisting of helium, argon, air, water vapor, carbon monoxide, carbon dioxide, hydrogen and combinations thereof.

10 13. The system as defined in claim 1, 2, 3, or 4 further including means for providing dissociable inert gas mixable with said working gas, the dissociable inert gas increasing the temperature gradient in said ionized arc.

15 14. The system as defined in claim 1, 2, 3, or 4 further including means separate from said means for injecting a quench/reaction gas, said separate means for injecting a cooling gas into said nano clusters, thereby minimizing agglomeration of the nano powder material or mixture.

15. The system as defined in claim 1, 2, 3, or 4 wherein said working gas flow direction is approximately vertical.